FOREST PEST MANAGEMENT
Pacific Southwest Region

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A BIOLOGICAL EVALUATION OF JACKSON LAKE, PRAIRIE FORK, LITTLE ROCK CREEK, AND BIG ROCK CREEK RECREATION AREAS, VALYERMO RANGER DISTRICT ANGELES NATIONAL FOREST

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PSW FOREST AND RANGE EXPERIMENT STATION
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ABSTRACT

Campgrounds, picnic areas and day use areas in three areas of the Valyermo Ranger District which receive heavy recreational use were evaluated for pest problems. The major pests noted were western dwarf mistletoe and limb rust on Jeffrey pine, true mistletoe on hardwoods, and true mistletoe on white fir. Annosus root disease was involved in tree mortality in a few spots. Bark beetles killed a few pines in an area where limb rust was prevelant. Alternatives to manage the major pests noted are discussed.

INTRODUCTION

Ronald E. Bassett, District Ranger of the Valyermo Ranger District, requested the assistance of the Forest Pest Management Staff in evaluating recreation sites in three areas of the Valyermo Ranger District including: (1) Jackson Lake; (3) Little Rock and Big Rock Creek and (3) Prairie Fork.

On May 21-25, 1984, James Allison, Pathologist, and David Schultz, Entomologist, of the Forest Pest Management Staff evaluated the areas requested. They were accompanied durir part of the evaluation by Alan Wright, Angeles Timber Management Specialist, Donald Beardsley, District Resource Officer, and Nicholas Giannettino, Assistant Resource Officer, Valyermo Ranger District.

Jackson Lake Recreation Area Observations

The Jackson Lake Area Recreation sites are located along the Big Pine Highway, Los Angeles County N-4, at elevations that range from 6100-6200 feet. The campgrounds and picnic areas in the Jackson Lake Recreation Area include: (1) Appletree Campground; (2) Peavine Campground; (3) Lake Campground; (4) Mountain Oak Campground; (5) Mescal Picnic Ground; and (6) Jackson Lake Picnic Ground. These recreation sites lie between two and three miles from the Big Pines Visitor Center. The topography within the campgrounds and picnic areas is level to gently sloping.

Appletree Campground

The tree species occurring within the limits of the eight unit campground are Jeffrey pine, white fir, California black oak, and live oak. Trees provide shade in areas adjacent to camp sites but the campground is under-stocked (basal area of 180 sq.ft/acre) with no regeneration present. The major pest in the campground is white fir true mistletoe (Phorandendron bolleanum sub sp. pauciflorum) in the crowns of the larger white fir. A minor pest is western dwarf mistletoe (Arceuthobium campylopodum) on Jeffrey pine. A large Jeffrey pine near site 2 is moderately infected with dwarf mistletoe (Hawksworth 6-point dwarf mistletoe rating of 3). A white fir adjacent to site 7, is hazardous due to mechanical injury which has girdled about 50% of the base.

Peavine Campground

There are four parking spurs within the campground. The vegetative cover consists of Jeffrey pine, white fir, and California black oak. The campground is heavily stocked with trees clumped around campsites but there is no regeneration. The main pest in the campground is western dwarf mistletoe (Arceuthobium campylopodum) on Jeffrey pine. It occurs throughout the area except in the vicinity of site 2. Jeffrey pines are moderately to heavily infected, with Hawksworth 6-point dwarf mistletoe ratings of 3 to 5 common. Pines near sites 3 and 4 have witches' brooms in the lower portion of the crown. The Hawksworth ratings of these trees range from 4-5. These trees will probably be attacked by insects when precipitation is below normal and the mistletoe continues to intensify. White fir true mistletoe (P. bolleanum subsp. pauciflorum) was found on white fir adjacent to site 1.

Lake Campground

The vegetative cover consists of a Jeffrey pine overstory and an understory of Jeffrey pine, white fir, and California black oak. There is a clump of Coulter pine adjacent to sites 6 and 8. They need to be pruned because they are beginning to interfere with the powerlines. The major pest problem present in the campground is western dwarf mistletoe (A. campylopodum, which occurs throughout the campground. Jeffrey pines, both in the overstory and understory are, in general, moderately to heavily infected with Hawksworth 6-point dwarf mistletoe ratings of 4 to 6 common. Witches' brooms are visible in the pines near the entrance to the campground and along the fence line separating the campground from the Big Pine Highway. Some of these trees are in the 5-6 range in Hawksworth's dwarf mistletoe rating. A small group of Coulter pine adjacent to site 5 are also infected with dwarf mistletoe. There is an annosus root disease center near site 4.

Although no significant current insect activity was detected, dwarf mistletoe and root disease both influence tree thrift and vigor and predispose trees and stands to attack by numerous species of bark beetles. Trees in this campground may well suffer mortality following a year or two of below normal precipitation because of the disease condition.

Mountain Oak Campground

The overstory and understory vegetation consists of Jeffrey pine and California black oak. The oaks occur in clumps throughout the campground. The campground is overstocked (basal area of 160 sq.ft/acre). The tree size, age class, and stand density varies from over-stocked young pole-size aggregations to open-grown, mature large sawtimber. A few Coulter pines, and giant Sequoia are adjacent to sites 4 and 5. The Jeffrey pines adjacent to site 6 through 8 are infected with western dwarf mistletoe (A. campylopodum). California black oaks throughout the campground are infected with true mistletoe. Near site 8 there is a hazardous oak. Hazardous limbs are present in oaks adjacent to sites 8, 14, and 16.

Mescal Picnic Ground

This picnic ground is overstocked with the tree size, age class, and stand density varying from over-stocked, young, pole-size aggregations to open-grown mature large sawtimber. Western dwarf mistletoe (A. campylopodum) is the major pest in the picnic ground. It occurs throughout the area. Jeffrey pine in the understory and overstory are moderately to heavily infected, with Hawksworth 6-point dwarf mistletoe ratings of 4 to 6 common. Numerous witches' brooms are present.

A few pines were dying in the vicinity of sites 1 and 2. Some of these trees contained larvae of the California flatheaded borer (Melanophila californica). The trees were probably predisposed to successful attack by these insects by the heavy dwarf mistletoe infection.

Jackson Lake Picnic Ground

The vegetative cover consists of California black oak, white fir, Jeffrey pine and sugar pine, with willows on the wetter sites adjacent to the lake The major pest in the picnic ground is western dwarf mistletoe (A. campylopodum) in Jeffrey pines. The Jeffrey pines throughout the picnic ground have moderate to severe infections (Hawksworth ratings of 3-5). Witches' brooms are present in many of the pines on the hillside overlooking the lake, along the trail that runs through the picnic ground, and adjacent to picnic area. True mistletoe is common on both California black oak and white fir. The pines will probably be attacked by insects when precipitation is below normal and the mistletoe continues to intensify.

JACKSON LAKE RECREATION AREA MANAGEMENT ALTERNATIVES

1. No Change In Present Management. Dwarf mistletoe infection levels are high in Peavine and Lake Campgrounds and Mescal and Jackson Lake Picnic Grounds. If nothing is done to control this disease, it will increase in intensity in trees already infected and spread to surrounding susceptible trees. Pines with dwarf mistletoe ratings of 1 through 4 will normally advance to the next higher class in about 10 years. Trees with ratings of 5 or 6 have a high probability of dying in 10 to 15 years. The long-term effect of dwarf mistletoe in pine is the decadence and possible loss of the host species as a major stand component. Tree aggregations with high basal areas have a high probability of being suc-

cessfully attacked by bark beetles or engraver beetles during periods of low precipitation.

The probability of attack is higher in trees under stress from dwarf mistletoe infections. The eventual impact of the dwarf mistletoe will be to decrease the species mix or to create treeless openings.

Fomes annosus in Lake Campground will persist in the infected stumps and roots until the wood is completely rotted. Trees on the edge of active annosus centers will become infected and will probably die after being attacked by bark beetles. Conifers planted in disease centers will become infected and die as their roots reach old infected roots and stumps and the fungus will be perpetuated in the area.

Conifers will compete with some of the existing oak trees resulting in a reduction of oak vigor and growth. That will slow wound healing, promoting heart rot, and increasing the rate of branch and tree failures.

True mistletoes will continue to intensify on its hardwood hosts and many of the presently uninfected but susceptible hardwoods may eventually be infected. Overhanging limbs with large mistletoe-induced swelling will pose an increasing hazard to people and property in the campgrounds and picnic areas. Growth will be reduced in the most severely infected trees and many will develop thin crowns, grow more suceptible to drought, and die prematurely.

True mistletoe on white fir will continue to buildup in the tall trees, because birds prefer to perch in their tops. The severe buildup that occurs over a period of many years in already-infected trees is caused by birds being attracted to, and spending prolonged periods of feeding on the mistletoe berries. The heavily infected trees are weakened, reduced in growth rate and sometimes killed. Spike tops, common in white fir infected with the parasite, are suscepible to decay and breakage and hence are considered hazardous in high-use sites. Weakened trees are predisposed to attack by insects and often die during drought or other periods of stress.

2. Reduce Impact of Western Dwarf Mistletoe. Dwarf mistletoe is widespread in some of the Recreation Areas. Since there are a number of areas involved thre are also many different control strategies involved. Based on the presence of brooms, presence of host species understory, stocking levels, etc., some of the management alternatives are applicable to an area and others are not (see Table 1).

A control program is an investment in the future health of the campground and picnic ground pine, and, if thorough and aggressive, will reduce infection levels and mortality while increasing tree vigor and longevity. See Appendix for information on setting up a Dwarf Mistletoe suppression project.

a. Pruning of Broomed Branches. Removing heavily-broomed branches is effective in increasing tree vigor of high-value trees in recreation areas. There are usually some infected branches left above the brooms which are pruned. Broom pruning will not affect the spread of dwarf mistletoe within the tree or stand. The objective of broom pruning is to increase a tree's vigor, and thereby to prolong its life, by removing a major source of nutrient and moisture drain. High value trees can be pruned of brooms in the lower crown if

after removal of the brooms, the tree will still have a live-crown ratio of 30% or more. When pruning, all broomed branches should be cut flush with the bole.

Pruning of all infected branches in infected trees in an attempt to eradicate the dwarf mistletoe is generally not recommended. But in exceptional cases where attempted on high-value trees, this treatment should be restricted to trees with a Hawksworth 6-class dwarf mistletoe rating of 1 or 2 which have infections restricted to the lower 1/3 of the crown. When pruning, all branches in the lower 1/2 of the crown should be removed. This treatment should not be attempted if it will result in a tree with a live-crown ratio of less than 30% or if the tree will be exposed to continued infection from adjacent infected trees. The trees should be reexamined every 2 years for a 6-year period and re-treated to remove previously undetected infections.

Pruning branches 1-inch or less in diameter with dwarf mistletoe plants within 6 inches of the bole is not effective because the parasite is already in the bole. For each 1-inch increase in branch diameter, the minimum safe distance for pruning increases 2 inches. For example; a 2-inch-diameter branch could be effectively pruned if no plants are closer to the bole than 8 inches. Green pine slash resulting from broom or branch pruning, should be treated to reduce the risk of pine engraver (Ips spp.) buildup. Slash created in the spring or early summer should be lopped and scattered, piled and burned while green, chipped, or removed from the site.

b. Remove Infected Overstory To Protect Regeneration. To prevent infection of understory trees, the infected overstory trees need to be removed to remove the source of inoculum. The remaining understory can then be thinned and pruned to remove dwarf mistletoe infections.

c. Thinning. Thinning of infected stands will aid in maintaining optimum growth of the residuals and reduce stress. Mistletoe infected trees should be selected against. The removal of all trees with 6-class dwarf mistletoe ratings of 5 and 6 should be considered because these trees have a high probability of dying in the next 10 to 15 years. Treat all freshly cut stumps with borax to prevent invasion by F. annosus and treat green pine slash to prevent engraver beetle buildups.

d. Create Buffer Strips. The creation of buffer strips (areas free of susceptible hosts) should be considered at the margin of dwarf mistletoe infections to prevent spread into or out of the treated areas. Natural buffers such as roads or stand openings can be used, or susceptible species can be removed and the strip planted with nonsusceptible species.

e. Encourage Tree Species Diversity. A mix of nonsusceptible species in infected stands provides a barrier to spread of dwarf mistletoe. Maintaining the present species mix should be encouraged in the Jackson Lake Area Recreation sites.

3. Reduce Impact of Fomes Annosus. Once annosus root disease is established in a stand such as at Lake Campground, no direct control is available. Control, therefore, involves prevention of new centers by decreasing the risk of stump infection, and silvicultural manipulation of infected stands to minimize the effects of the disease. The following alternatives are available:

TABLE 1. APPLICABILITY OF DWARF MISTLETOE TREATMENTS TO AREAS ON VALYERMO RANGER DISTRICT, ANGELES NATIONAL FOREST

AREA	TREATMENTS					
	BROOM PRUNE	REMOVE INFECTIONS OR PRUNING	REMOVE OVERSTORY	THIN	BUFFER STRIP	ENCOURAGE SPECIES DIVERSITY
APPLETREE CAMPGROUND	NA[1]	X	NA	NA	NA	NA
PEAVINE CAMPGROUND	X[2]	X	NA	NA	NA	NA
LAKE CAMPGROUND	X	X	X	X	Keep DM out of lower portion of campground	With appropriate native hardwood species
MOUTAIN OAK CAMPGROUND	NA	X	NA	X	Keep DM out of lower portion of campground	With appropriate native species
MESCAL PICNIC GROUND	X	NA	X	X	NA	With appropriate native species
JACKSON LAKE PICNIC GROUND	X	X	NA	Jeffrey pines near picnic tables	NA	NA
PRAIRIE FORK RECREATION AREA	NA	X	X	X	Around Lupine campground	With appropriate native species

[1] NA = Not applicable

[2] X = Available treatment

a. Prevent Stump Infections. Application of granular borax to freshly cut coniferous stumps is effective (90%) in preventing new infections. The chemical is toxic to the spores of F. annosus, but has no effect on existing infections. Borax application is required on all coniferous stumps cut in and near developed recreation sites (FSM R-5 Supplement 2305 and 2331.33). Application requires the prior submission of a pesticide use proposal to Forest Supervisor.

b. Plant Hardwoods. Revegetation of active annosus centers should be done only with resistant species. All conifers are susceptible to the disease. Leaving the centers barren or revegetating with resistant hardwoods will allow the fungus to eventually die out so that conifers can again be regenerated. Unfortunately, this may take up to 50 years or more. Favoring hardwoods already present and planting suitable hardwoods will provide shade as well as establish a barrier of non-susceptible roots that may limit the spread of infection centers.

4. Control True Mistletoe. At present, control of Phorodendron is seldom practiced or needed in forest situations other than selection against infected trees when practical. When control is needed in individual high value trees, several options are available.

a. Prune Infected Branches. Prune infected limbs one foot or more below the point of mistletoe attachment or visible swelling, preferably at the bole or nearest crotch. Because of long-range spread by birds, pruning will not eradicate the mistletoe. However, since the parasite often takes 5-10 years to develop to damaging proportions, re-treatment will not be necessary for several years. Prune carefully to avoid excessive damage to the host and to prevent decay; in general, do not prune branches larger than 4-6 inches in diameter, as large wounds will heal slowly and usually become extensively decayed. Treating pruning cuts with commerical preparations does not prevent decay.

b. Remove Mistletoe Plants. Removing mistletoe foliage will reduce some of the parasite's drain on the host, and may reduce local infection rates by eliminating the seed-bearing plants that attract birds. Shoot removal is labor-intensive and must be repeated every 2-3 years.

c. Wrap Infected Branches. Cut off the mistletoe plant flush with the limb or bole. Wrap the severed point with a band of black plastic wide enough to exclude light, and tie the plastic to the limb with twine or flexable tape. Since mistletoe cannot survive without light, it may die within a year or two. However, this method is time consuming and not particularly effective: prevention of shoots is ofter only temporary, and the wrappings are unsightly; the limbs may be heat-damaged, and callus tissue may form under the wrappings; the wrappings may provide a refuge for insects or decay fungi that further damage the host

d. Remove Trees. Cut host trees in and around campgrounds and picnic areas that are severely infected and cannot be pruned. In the case of oaks, small-to moderate-size oaks may be cut as close to the ground as possible and allowed to sprout. The sprouts should then be managed.

5. Integrate Treatments. Management Alternatives 2 through 4 are not mutually exclusive. They can be used alone or in combination in various parts of the Jackson Lake Recreation Area to produce the results desired by the resource manager. Consideration of the interaction among all insects and disease problems present in the area will result in a successful integration of pest management strategies.

BIG ROCK CREEK RECREATION AREA OBSERVATIONS

Big Rock Creek Day Use Area

The Big Rock Creek Recreation Area lies along Big Rock Creek in the San Andreas Rift zone at an elevation of 4,350 feet. There are approximately four miles of stream access. The overstory vegetation consists of cottonwood and sycamore. A number of trees along the stream have the following problems: (1) exposed root systems; (2) dieback in crown; (3) hazardous limbs; (4) compaction of soil around roots and (5) true mistletoe. This area receives heavy day usage on weekends during the summer season from heavily populated adjacent areas of Los Angeles County.

The roots of sycamore and cottonwoods along the creek are exposed because of the seasonal fluctuation in water levels which tends to wash away soil and expose roots. The exposure of root systems and individual roots cause the death of the fine water absorbing roots. The death of these fine roots is expressed in crown dieback in affected trees. The soil in the root zone of many of the sycamores and cottonwoods is compacted apparently by people seeking shade or simply hiking along the creek. The dieback in the crowns of the sycamore and cottonwood trees along the stream banks have created some hazardous limb situations.

Sycamore Flat Campground

This campground, which lies along Big Rock Creek Road, has 11 campsites. The overstory vegetation consists of many different species of trees, ranging from sycamores, cottonwood, sweetgum to knobcone x Monterey, Arizona cypress, and Allepo pine. Newly planted trees include bigcone Douglas-fir and incense cedar. True mistletoe is present in sycamore growing adjacent to sites 1-6. In the more sunny open areas there is a need for more screening vegetation between the campsites.

LITTLE ROCK CREEK RECREATION AREA OBSERVATIONS

Little Rock Creek Day Use Area

The Recreation Area extends about seven miles along Little Rock Creek from the Little Rock Reservoir to Little Cedars Campground. The elevation in this area ranges from about 3,300 feet at Little Rock Reservoir to 4,700 feet at Little Cedars Campground. The overstory vegetation along the creek consists of sycamore, willow, alder, and cottonwood. Most of the sycamores along the creek

are infected with sycamore anthracnose which has caused extensive dieback in the crowns. The other tree species are exhibiting extensive dieback due to compaction and root exposure.

Little Sycamore Campground

Little Sycamore Campground is located about five miles from the Little Rock Reservoir on FS 5 N04 at an elevation of 3,900 feet. There are eight units within the campgrounds. The campground vegetation consists of sycamore, cottonwood, and black locust. True mistletoe (Phoradendron macrophylum) is present on both the sycamores and the cottonwoods. P. macrophylum poses a problem to all hardwood trees in the campground because of its wide host range (see appendix). Most of the sycamores are infected with sycamore anthracnose. There are several hazardous trees in the campground: (1) sycamore with extensive decay at site 1; (2) cottonwoods with extensive decay near sites 1 and 3; and (3) cottonwood at site 8.

Basin Campground

Basin Campground is located about two miles south of Little Rock Reservoir at an elevation of 3,400 feet. There are 24 units in the campground. The vegetative overstory consists of sycamore, juniper, and pinyon pine. This campground has a number of sites without overhead shade and they are not as desirable nor chosen as often as the sites with large trees. No pests were noted in the campground.

BIG ROCK CREEK AND LITTLE ROCK CREEK MANAGEMENT ALTERNATIVES

1. No Change In Present Management. True mistletoe will continue to intensify on its hosts, and many of the presently uninfected but susceptible hardwoods may eventually be attacked. Overhanging limbs with large mistletoe-induced swellings will pose an increasing hazard to visitors. Growth will be reduced in the most severely-infected trees, and many will develop thin crowns, grow more susceptible to drought, and die prematurely. Sycamore anthracnose will continue to cause defoliation of California sycamore when there are wet springs and abundant inoculum from the blighted twigs, cankers, and latent bud infections present on trees infected the previous spring. Seasonal water level fluctuations in the creek will cause continued exposure of roots and subsequent death, which will continue to result in dieback in the crowns of the affected trees and the formation of hazardous limbs and trees.

2. Control True Mistletoe. See Section on true mistletoe control in Jackson Lake Area Recreation Sites.

3. Control Sycamore Anthracnose. At the present time there is no control measure for sycamore anthracnose. In areas where sycamore anthracnose is a problem year after year, other native tree species should be favored.

4. Reduce Erosion and Compaction of Soil Around Trees. Stablize stream banks to reduce erosion and subsequent death of roots and dieback in crown. Provide walkways along streams to reduce compaction of soil around trees.

5. Integrate Treatment. Management alternatives 2 through 4 are not mutually exclusive. They can be used alone or in combination in various parts of the Big Rock Creek and Little Rock Creek Recreation Areas to produce the desired results. Consideration of the interactions among all insects and disease problems present will result in a successful integration of pest management strategies.

PRAIRIE FORK RECREATION AREA OBSERVATIONS

Prairie Fork is a dispersed recreation area of about 90 acres at elevations that range from 5,600 to 7,000 feet. It is about 11 miles by road from the Big Pines Information Center. The overstory and understory is mainly Jeffrey pine with a few scattered white fir. The stand is overstocked, with many pole and sapling-sized trees. Western dwarf mistletoe is heavy in the overstory in scattered portions of the area and has spread to the understory of young Jeffrey pine. Limb rust (Peridermium stalactiforme) is also present in the overstory Jeffrey pine. Often both dwarf mistletoe and limb rust were found on the same branch. One annosus root disease center was found just north of intersection of the main Prairie Fork Road and the road to Lupine Campground. Confirmation was based on the presence of Fomes annosus conks within stumps. Several dead and dying pines were present in this center.

A pocket of Jeffrey pine were killed by pine engravers (Ips. spp.). These trees were probably predisposed to successful attack by these insects by dwarf mistletoe and limb rust infections, and below-normal precipitation.

Management Alternatives

1. No Change In Present Management. Dwarf mistletoe infection levels are high in parts of Prairie Fork area. If nothing is done to control this disease, it will increase in intensity in trees already infected and spread to surrounding susceptible trees. Severely infected trees have a high probability of dying in 10 to 15 years. Limb rust will continue to spread and intensify causing the death of infected trees and predisposing other infected trees to attack by bark beetles.

Fomes annosus will persist in the infected stumps and roots until the wood is completely decayed. Host trees on the edge of the active anosus center will become infected and die, probably as a result of bark beetle attack. Conifers planted in disease centers will die as their roots encounter old infected roots and stumps and the fungus may be perpetuated in the area.

2. Reduce Impact of Dwarf Mistletoe. See Alternative 2 for Jackson Lake Area.

3. Reduce Impact of Fomes Root Disease. See Alternative 3 for Jackson Lake Area.

4. Reduce Impact of Limb Rust.

a. Remove infected trees. The infected trees will not recover and will be eventually killed by bark beetles once growth slows down.

b. Pruning of infected branches. The pruning of infected branches will remove sources of infection for other susceptible trees in stand. Pruning should not be attempted in trees where rust has already entered the bole of tree because of the ability of the rust to extend in the bole until green branches are reached and invaded.

5. Integrate Treatment. Management alternatives 2 through 4 are not mutually exclusive; they could be used alone or in combination in various parts of Prairie Fork Recreation Area to produce the desired results. Consideration of the interactions among all insect and disease problems present will result in a successful integration of pest management strategies.

The objective of any pest management activity in the Recreation Area should be to promote the growth of healthy and vigorous, all-aged, mixed species, properly stocked stands. The integration of suppression and prevention methods into the long term management of the area is necessary to completely fulfill this objective.

Forest Pest Management personnel are available to provide technical assistance both on the ground and in the planning process in order to reduce pest-related losses. This includes assistance with planning dwarf mistletoe suppression projects and application for funds.

APPENDIX

BIOLOGY OF PEST ORGANISMS

WESTERN DWARF MISTLETOE

Western dwarf mistletoe, Arceuthobium campylopodum, infects Jeffrey, ponderosa, knobcone, and Coulter pines. Other conifers or hardwoods are not infected by this particular species. Dwarf mistletoes are obligate parasites that are completely dependent on their host for support, water, and most of their mineral and organic nutrients. They often cause the formation of "witches' brooms" or dense masses of distorted branches, on the host that divert nutrients from the rest of the tree. Infection can cause growth reduction, abnormalities, mortality and predisposition to attack by other pests. In particular, infected trees appear to be more susceptible to attack by bark beetles and the California flatheaded borer. The dwarf mistletoe/bark beetle complex is responsible for 40 to 60% of the pine mortality in southern California during years of normal precipitation. Mortality is more severe when other stress factors occur, such as drought, poor site, or competition in overstocked stands.

Dwarf mistletoe spreads between trees and within crowns of trees by means of small seeds that are forcibly ejected into the air. Spread from overstory to understory is limited to the distance the seeds are shot - generally 20 to 60 feet, but as much as 100 feet if assisted by wind or on steep slopes. Dwarf mistletoe spreads upward in pine at an average rate of 4 inches per year.

ANNOSUS ROOT DISEASE

Fomes annosus is a fungus that attacks a wide range of woody plants, causing a decay of the roots and butt and the death of sapwood and cambium. All conifer species in California are susceptible to the fungus. Hardwood species are rarely damaged or killed. Madrone (Arbutus menziesii), and a few brush species (Arctostaphylos spp. and Artemisia tridentata) are occasional hosts.

During favorable periods, the fungus forms fruiting bodies (conks) in decayed stumps, under the bark of dead trees, or in the duff at the root collar. The fungus becomes established in freshly cut stumps from air-borne spores produced by conks, and then grows into the root system. The fungus subsequently spreads to healthy roots of surrounding susceptible species via root contacts. Local spread of the disease outward from an infected stump typically results in the formation of a disease center, with stumps and older dead trees near the center and fading trees on the margin. The centers continue enlarging until they reach barriers, such as openings or groups of non-susceptible plants.

The fungus may remain alive for as long as 50 years as a saprophyte in rotting roots and stumps. Young susceptible trees invading the site often die after their roots contact old infected root systems in the soil.

TRUE MISTLETOE IN HARDWOODS

Two species of Phoradendron commonly attack hardwoods on the Angeles National Forest. P. villosum occurs almost exclusively on oaks, although manzanita, buckeye, and black locust are occasionally infected. Mature leaves are somewhat stiff and hairy, and are approximately 0.6-1.8 inches long by 0.4-0.9 inches wide. P. macrophylum infects some 60 hardwood species of about 30 genera, including cottonwood, willow, poplar, black locust, maple, walnut, alder, and sycamore; it does not attack oaks. Mature leaves are slightly hairy, they are usually more than 1.1 inches long by 0.7 inches wide, and about twice as large as those of P. villosum.

Like the dwarf mistletoes, the true mistletoes are flowering plants that require a living host to survive. They are generally less demanding of their hosts than the dwarf mistletoes, yet can be serious pests where individual trees are of high value, as in parks and campgrounds. Although they are completely parasitic, they produce many of their required nutrients by photosynthesis and usually require only water and minerals from their hosts. However, if the green aerial shoots of the mistletoe are removed, the parasite's root system can utilize the host's nutrients and remain alive within an infected branch for many years.

Mistletoe infections are spread mainly by birds-including robins, bluebirds, thrushes, and cedar waxwings--that feed on the berries. Birds digest the pulp of the berries and excrete the living seeds, often depositing them onto susceptible trees. A viscous coating and hair-like threads on the outer surface of the seeds attach them firmly to twigs and branches, where they germinate and infect the host tissues.

Young or small trees are seldom infected by true mistletoes. In nearly all cases, initial infection occurs on larger or older trees because birds prefer to perch in their tops. Severe buildup of mistletoe often occurs in an already-infected tree because birds are attracted to the mistletoe berries and may spend prolonged periods feeding on them.

The damage caused by true mistletoes usually outweighs whatever economic or aesthetic value they may have. Severely infected trees are weakened, reduced in growth rate, and sometimes killed. Weakened trees are predisposed to attack by insects and often succumb to drought or other stresses. Branches heavily-laden with mistletoe may break during storms or high winds, and trunk swellings may provide entry to decay fungi, increasing the hazard to people and property in developed sites.

WHITE FIR TRUE MISTLETOE

The white fir true mistletoe (Phoradendron bolleanum subsp. pauciflorum) infects only white fir. The biology is similar to the true mistletoes of hardwoods.

Trees heavily infected by true mistletoe are weakened, reduced in growth rate, and sometimes killed. Spike tops, common in white fir infected with the parasite, are susceptible to decay and breakage and hence are considered hazardous

in high-use sites. Weakened trees are predisposed to attacks by insects and often die during drought or other periods of stress.

SYCAMORE ANTHRACNOSE

Anthracnose is one of the most common foliage diseases of hardwoods. California sycamore, Platanus racemosa, is commonly infected by Gnomonia platani which causes the anthracnose disease. The ragged appearance of many of the California sycamore is due to the repeated defoliation by the anthracnose disease.

Anthracnose appears in the spring shortly after bud break. Typical symptoms of anthracnose are irregular, dead blotches that merge together to cause death of most of the leaf and often result in defoliation. Symptoms are not confined to the leaves but may include twigs, buds, and shoots. Shoot infection causes the death of twigs and the emergence of lateral buds to form witches' brooms on the heavily infected trees. Blighted twigs, cankers, and latent bud infections are a source of infection the following spring. Spores, whose dissemination and infection are dependent upon free water in the form of rain or dripping fogs, are produced in the spring on infected twigs and blighted buds and leaves.

Virtually complete defoliation for several years is not uncommon. Refoliation following early defoliation can keep trees alive indefinitely.

LIMB RUST

Peridermium stalactiforme causes limb rust of Jeffrey pines on the Angeles National Forest. Its alternate hosts are Indian paintbrushes (Castilleja spp.) and related genera of Scrophulariaceae. Infection of pine results only from spores that are produced on these alternate hosts. The causal fungus is indistinquishable from the canker-causing P. stalactiforme which occurs on lodgepole pine.

Limb rust, unlike other pine rusts, is a systemic disease that causes the progressive killing of branches until the infected trees die. Trees die after the loss of about 80 tp 90 percent of the crown. The loss of crown is very slow because linear spread is about 1.5 feet per year. Considerable reduction in increment precedes death of infected trees because height and diameter growth rates of infected trees becomes negligible after about 50 percent of their crowns are dead.

Many of the trees are predisposed by the rust and die from secondary causes before 80 percent of the twigs are killed by the fungus. The principal secondary agents that attack and kill rust-weakened pines are bark beetles.

PINE ENGRAVER BEETLE

Pine Engraver Beetle. Pine engravers (Ips spp.) will breed either in the tops of live pine trees or in fresh green slash. Attacks on live trees are usually limited to trees which are suppressed, or stressed by dwarf mistletoe, root disease, drought, fire, overstocking, or the attack of other insects. If fresh slash is available in the spring, the pine engravers may build up in an area

and cause locally heavy top killing by mid-summer. Attacks are made with the coming of warm weather in the spring. A new generation is produced in 6-8 weeks in the spring, to 4-6 weeks in mid-summer (August). Thus, several overlapping generations per year may be produced. The winter may be passed in any of the life stages of larvae, pupae, or adults, depending upon species involved.

Outbreaks in standing, healthy trees are sporadic and of short duration, and are often associated with some temporary stress or shock afflicting the host species, such as severe competition or sudden opening of the stand. Tree killing frequently occurs where green pine slash, which serves as breeding habitat, is left untreated during spring and summer.

Fresh pine slash caused by thinning, dwarf mistletoe control work, construction or winter storm breakage can be modified in a number of ways to make it unsuitable for pine engraver breeding. One approach to minimizing damage is to schedule slash-generating activities mostly in the late summer, fall and early winter, when the beetles are not flying or the slash has a high probability of dying out before the beetles can complete their development. Green pine slash created during the spring and summer should be treated to prevent the buildup of pine engraver populations. Because pine engravers can complete their development in about a month under ideal conditions, treatment should be carried out soon after cutting to be effective. Some methods of slash treatment that might be acceptable in dispersed recreation areas would include lopping and scattering slash in sunny areas to speed its drying out, crushing or mashing slash with logging equipment to make it unsuitable for pine engraver breeding, or piling and burning the slash within a month of cutting. Broadcast burning the slash might work if it could be done while the slash was green without damaging the residual stand. Another method which might work is to pile slash in a sunny area and tightly cover the pile with clear plastic. If the temperature under the bark of slash in all parts of the pile reaches 120 degrees F, all brood currently in the pile will be killed. Lower temperatures will not be effective and, where successful, this method will not prevent reinfestation of slash piles. The most acceptable methods of slash treatment in high-use recreation areas would probably be disposal by chipping or removal from the site.

CALIFORNIA FLATHEADED BORER

The California Flatheaded Borer (Melanophila californica) principally attacks Jeffrey and ponderosa pines, although it may be found in other pine.

It is most severe in stands located on sites where environmental stresses common. Decadent or unhealthy trees are most frequently attacked, along with an occasional top of a thrifty, vigorous tree.

Eggs are laid in bark crevices of the host tree. Newly hatched larvae penetrate directly through the bark to the phloem. Here the larvae may feed from a few months to 4 years without any apparent effect on the host tree. Should host vigor and larval abundance not allow them to succeed, the larvae cut very short galleries before they are killed. These galleries do not seriously

injure the tree and are overgrown by the cambium. Should conditions be, or become, favorable for the larvae and unfavorable for the tree, the larvae develop rapidly and destroy the cambium.

Although this insect can kill trees weakened by dwarf mistletoe and root disease, its primary importance is rendering trees increasingly susceptible to bark beetle attack.

DWARF MISTLETOE SUPPRESSION

Control alternatives

Dwarf mistletoe treatments may include one or any combination of the following:

1. Removing infected overstory trees to protect regeneration.
2. Removing witches' brooms to prolong tree life.
3. Removing all infections by pruning to eliminate the parasite.
4. Removing heavily infected trees that cannot be successfully pruned.
5. Thinning to remove infected trees and release residual trees.
6. Creating buffer strips to prevent re-entry of dwarf mistletoe.
7. Favoring resistant species (includes planting).
8. Destroying heavily infected stands or aggregations and then regenerating.

Control procedures and guidelines

The first step in a control project for campgrouds is to map the areas of infestation. Then each infected tree and the area around it must be examined to decide whether to remove the mistletoe or to remove the entire tree. The enclosed Dwarf Mistletoe Survey Data Sheet (page 4) may be used to help determine individual tree treatments and to estimate project costs. In making these decisions and planning a project the guidelines below should be used. High-value trees and special situations may require deviation from these generalizations. However, deviations should be kept to a minimum in order to maintain treatment effectiveness.

1a. Trees with a dwarf mistletoe rating (DMR) of 3 or less - prune off all lower branches, both healthy and diseased, at the bole up to and including the second whorl of branches above the highest visible mistletoe infection. Experience has shown that removing branches only up to the highest infection or even one more whorl almost certainly results in latent infections appearing in 3-5 years.

b. Trees with DMR of 4, and no mistletoe in the upper 1/3 of crown - prune to remove infections or take tree out depending on the condition of crown, tree vigor, distribution of mistletoe and importance of tree.

c. Trees with a DMR or 5 or 6 - remove; in special situations these may be broom pruned.

2. A tree should have at least 30% live crown after pruning.

3. Whenever possible avoid removing more than 50% of a tree's live crown.

4. Bole infections - if the stem diameter at the point of infection is less than 6 inches, remove the tree. Bole infections are not serious from the standpoint of spreading mistletoe, but they deform and/or lead to mortality of small trees and failure of large trees.

5. Branches 1 inch or less in diameter with mistletoe plants within 6 inches of the bole are not prunable because the parasite is probably already in the bole. For each 1-inch increase in branch diameter, the minimum safe distance for pruning increases 2 inches. For example, the minimum safe pruning distance from the bole to mistletoe plants for branches 1 to 2 inches in diameter is 8 inches.

6. Removing witches' brooms from high-value trees will increase the vigor and longevity of those trees. It may not be possible or acceptable to remove all remaining branch infections, and this means that a source of mistletoe seed is still in the crown.

7. Some infections may be left in desirable isolated trees where there are no susceptible trees within range of remaining mistletoe shoots/seeds. This is often the case when broom pruning is used.

8. In very dense aggregations it is often best to thin out infected trees even though they are prunable. Make decisions based on tree vigor, spacing, and expected response of residual trees.

9. Buffer zones, defined as areas free of susceptible hosts, are essential to prevent mistletoe from re-entering the control area. Examples include meadows, roads, rivers, clearings and plantations of non-host trees. Construction of new roads, structures of campsites can also be used to create buffer zones.

10. Green pine slash generated by pruning or tree removal should be treated to reduce the risk of pine engraver (Ips spp.) buildup. Slash created in the spring or early summer should be lopped and scattered, piled and burned while green, chipped, or removed from the site.

11. Treat all freshly cut stump surfaces with borax to prevent the establishment of Fomes annosus root disease.

12. Definitely plan to re-enter, evaluate, and treat the campgrounds in 3 to 5 years to remove previously undetected latent infections. Dwarf mistletoe can seldom be eliminated with one entry.

13. A post-suppression evaluation is essential to monitor project effectiveness and thoroughness. This evaluation should be designed before ground work is begun and completed soon after treatment is finished. Completing the Dwarf Mistletoe Survey Data Sheet can help document treatment effectiveness.

FOREST PEST MANAGEMENT SUPPRESSION FUNDS

FPM expects to have dwarf mistletoe control funds for the current fiscal year. If the District decides to request suppression dollars, the following must be

submitted to FPM for approval:

- a project proposal, Form FS-3400-2;

- an environmental assessment that includes project objectives, a copy of this evaluation, a project work plan, an analysis of economic efficiency (FSM 1970 and 3433) and a post-suppression evaluation plan.

At your request, the FPM Staff is available to provide whatever assistance or additional information they can for satisfying these requirements. We suggest that prior to beginning any preparation of a project proposal, our staff should meet with Forest/District personnel to go over actual dwarf mistletoe field situations and appropriate treatment strategies. In addition, plans for a post-suppression evaluation and approaches to an economic analysis can be discussed.